~~ELECTRONIC TRIPPING DEVICE COMPRISING CONTROL AND DISPLAY ELEMENTS~~

The present invention relates to an electronic tripping device, in particular for low-voltage circuit-breakers, having adjusting and display elements for the tripping parameters to be adjusted, such as for the tripping current in the case of overload and for the corresponding delay time, the switching and display elements cooperating with adjusting devices for the parameters, and the adjusting and display elements being mounted at an operating face of the tripping device.

There are analogously and digitally operating tripping devices. The analogously operating tripping devices simulate a tripping value, for example, a tripping current, generally using resistors and capacitors. The digitally operating tripping devices contain a microprocessor having a permanently input program and work in cycles, i.e., they check for example, the level of the current as well as the given requirements within the scope of a sequential sequence, and decide whether or not tripping should be carried out, giving a corresponding tripping command if indicated. In ~~both, it must be adjustable by a user via suitable adjusting elements~~ both tripping devices whether, or rather when a tripping command is to be emitted.

Conventional analog tripping devices

In ~~the analog tripping devices known heretofore, as a rule,~~ the tripping parameters are adjusted with the aid of potentiometers, rotary coding switches, or DIP switches which can be accessed at the operating face of the tripping device.

Used in digitally operating tripping devices are equally arranged coding switches, possibly of the same kind, which define a corresponding ~~operating shaft~~ switching threshold by a combination of positions. All these adjusting and coding switches, which generally contain mechanical contacts, are complicated, very

small elements whose reliability frequently leaves something to be desired, in particular because these switching devices, which are provided with contacts and which are extremely delicate due to their small size, can easily be impaired by dust, moisture, and vibrations frequently found in the environment of switching stations. In addition, these coding switches are operated at very low voltages and small currents. If the intention is for the mentioned deficiencies to be eliminated, considerable outlay is required, resulting in a considerable increase in price. Also, the readability is often unsatisfactory since, due to the space requirements, very small adjusting switches having correspondingly small scales are chosen.

Apart from the adjustment of tripping devices using mechanical switches of the mentioned kind, it is ~~known~~ conventional to store all adjustment values in a chip card and to transfer the adjustment values by inserting the chip card into the tripping device which possesses a card reader. A design approach of that kind is shown in Fig. 1 of German Patent DE-OS 44 45 079. On the control console containing the control elements, the display, and the hand lever for charging the stored-energy spring mechanism, the tripping unit is discernible as well which has a field with which the chip card is brought into contact. The chip card contains the adjustment values for the tripping unit, and is connected thereto via contacts, as a result of which the values stored on the chip card are transferred to the tripping unit. If the chip card is not put on, the tripping device is fixed at a basic adjustment having the lowest values possible so that no dangerous condition can arise. That is, without the chip card, the switch is operated at its minimum values.

Another proposal provides for the adjustment to be carried out via a serial interface with which the tripping devices can be equipped for transferring tripping values. However, this means that it is required to go close to the tripping devices with a notebook computer or

with another special hand-held controller, to connect or plug in this notebook or hand-held controller, and to look at the display. In the process, a checking of the storage of the adjustment in the tripping device is difficult or at least requires considerable outlay and, in fact, an extra device is required which must be connected for every adjustment, and which, in addition, is complicated and expensive.

In low-voltage circuit-breakers, LCD bar displays having a driver circuit are ~~indeed known per se from U.S. Patent~~ described in U.S. Patent No. 4 429 340; in that case, however, they are used to indicate the current presently carried by the switching device, and have nothing to do with the adjustment of the tripping quantities of auxiliary releases or any adjusting operations at all. They are used for a completely different purpose, namely just as indicator, and consequently do not interact with any adjusting elements.

In general, a plurality of adjusting devices is required according to the variety of protective functions which an electronic tripping device can perform. Apart from the difficulty of arranging the adjusting devices in a manner that they are clear and easily accessible to the user, the interconnection of the adjusting devices with the electronic modules of the tripping device additionally requires a not inconsiderable outlay.

Summary.

~~This results in~~ An object of the present invention ~~object of the present invention~~ is to provide adjusting controls for adjusting the parameters of the electronic tripping devices in which the mentioned mechanical adjusting switches are substituted by subassemblies which are technically better, less delicate, significantly simplified, consequently cost-effective, easily readable and easy to handle for the user, and which are reliable and inexpensive.

This object is achieved according to the present invention by using LCD elements in conjunction with a rugged key control in

lieu of miniaturized mechanical circuit closers having correspondingly small scales, the LCD elements serving as display elements for the respective parameters to be adjusted, and the key switches being used as adjusting elements. In this context, the adjustment of the tripping values and consequently the control of the LCD display elements is preferably carried out via only one key set composed of three keys having the following functions:

- Key 1: Selection of the desired entry field in a continuous sequence;
- Key 2: Calibration,
  increase of the adjustment values in predefined steps of a bar display or gradually in fine steps to stepless in the case of an alphanumeric display;
- Key 3: Activation of the display fields,
  supply of an auxiliary power if the tripping device is not connected to the electrical network and, therefore, an auxiliary power is required. In this case, an auxiliary power source is brought into circuit via key 3 for a short time. This can be, for example, a battery or a capacitor.

The LCD displays can be designed as bar displays or as alphanumeric displays. In the case of bar displays, a scale, which can be executed with differing fineness in uniform steps, is arranged next to the LCD display. Then, the bar of the LCD display can have a differing height, in each case according to the parameter value to be displayed, the upper end of the bar indicating, at the scale, the value to be adjusted, or the bar can move along the scale as a narrow, line-like bar according to the value to be displayed.

In alphanumeric displays, the adjusted value is displayed in a manner that is it is directly readable as a number.

In this context, each of these three LCD elements is

controlled using the above-mentioned keys in the mode described in greater detail in the following. Using the first key, the desired entry field is selected in a continuous sequence, i.e., each time the key is pressed, the field following the currently selected field is selected.

Using the second key, the tripping parameter of the selected field is adjusted in such a manner that, each time the key is pressed, the adjustment value is increased in the predefined steps or even continuously. In this context, as ~~already explained~~ described above, the grading can be stepped coarsely or finely in the case of a bar display, as well as finely stepped to stepless in an alphanumeric display. When the highest value is reached, the display returns to the lowest value the next time the key is actuated so as to increase again in response to further actuation. The third key for activating the display field is pressed only if the switch is not connected to the electrical network or switched off, i.e., if no voltage is applied to the auxiliary release. Then, in fact, an auxiliary supply is brought into circuit for the adjusting device. Otherwise, this device is always active. The auxiliary supply can be a battery or a capacitor which retains its charge for days if it is not brought onto load, and which is able to energize electronic loads having low current consumption of the order of microamperes for hours.

It is also possible to use LCD elements which, irrespectively of whether alphanumeric or graphic displays are used, permanently present the information to be displayed without supply of energy, subsequent to feeding the information to the display. This makes it possible for the power demand to be further reduced since the control power, which needs to be supplied during the adjustment of the auxiliary release in the zero-current state, must be provided only for a short time. LCD elements of that kind are offered by the Kent company.

Using the proposed display, it is possible for a plurality of

parameters to be adjusted. The adjustable parameters of the tripping device ~~are preferably~~ may be for example divided into four groups: inverse time-delay tripping, instantaneous tripping, short-time-delay tripping, and time-delay ground-fault tripping. In this context, the adjustment is based on a percentage of the rated current of the current transformer, the rated current, in turn, being determined by the fitting of the circuit-breaker with specific current transformers. Therefore, this rated transformer current is indicated at the operating face of the tripping device. Since at least two adjustment quantities are required for each parameter, namely threshold value and magnitude of the desired time delay, provision is made for two adjustment possibilities, respectively, according to the present invention consequently two display fields, in conjunction with a shared adjusting key set.

~~In the following, the present invention is explained in greater detail on the basis of preferred exemplary embodiments depicted in the Figures.~~

Brief Description of The Drawings

Figure 1 shows a schematic representation of an operating face of an electronic tripping device according to the present invention having a bar LCD display.

Figure 2 shows a schematic representation of an operating face of an electronic tripping device according to the present invention having an alphanumeric LCD display.

Figure 3 shows another design of a bar LCD display.

Figure 4 shows a block diagram of an electronic tripping device according to the present invention.

Detailed Description

The operating face 1 of an electronic tripping device shown in Figure 1 has eight LCD displays 2 through 9 which are designed as bar LCD displays. In this context, the bar displays are executed in such a manner that in each display, for each

parameter, a narrow bar 10 moves along a scale 11 existing in each display.

As shown in Figure 3, the bar display can also be designed in such a manner that bar 12 can in each case have a different height in LCD display 2 through 9, in accordance with the magnitude of the parameter to be adjusted and, consequently, to be displayed, top edge 13 of bar 12 then expediently indicating this value on scale 11 which is arranged next to LCD display 2 through 9.

These display types which feature a bar display are suitable for a relatively coarsely stepped adjustment. If a finer grading, which can be made finer up to stepless, continuous adjustment, is desired, it is expedient to use an alphanumeric display.

This is shown in Figure 2 in a substantially identical operating face 1 of an auxiliary release, LCD displays 2a through 9a of the operating face having an alphanumeric design.

In this case, the adjustable parameters of the tripping device are divided, for example, into four groups: long-time-delay tripping, instantaneous tripping, short-time-delay tripping, and time-delay ground-fault tripping. In this context, the adjustment is based on a percentage of the rated current of the current transformer, the rated current, in turn, being determined by the fitting of the circuit-breaker with specific current transformers. Therefore, a sign 19 indicating this rated transformer current I_n is provided on the operating face of the tripping device. Since at least two adjustment quantities are required for each parameter, namely threshold value and magnitude of the desired time delay, provision is made for two adjustment possibilities, respectively, according to the present invention consequently two display fields, in conjunction with a shared adjusting key set.

Thus, for example,

LCD display 2a shows:	I_r = percentage of the rated transformer current;
LCD display 3a shows:	the time delay in seconds;
LCD display 4a shows:	the characteristic numeral of a multiple of I_n (instantaneous tripping);
LCD display 5a shows:	percentage of I_r;
LCD display 6a shows:	the characteristic numeral of a multiple of I_n (or I_{rp}) for short-time-delay tripping;
LCD display 7a shows:	time delay is switched off;
LCD display 8a shows:	the characteristic letter for the percentage of I_n in the case of a ground fault; and
LCD display 9a shows:	the time delay in ms.

Each of LCD displays 2 through 9a is controlled using only three keys 14 through 16, independently of the type of the display.

Via first key 14, the desired LCD display 2 through 9a is selected in a continuous sequence, i.e., each time key 14 is pressed, the display following the currently selected display is selected. Using second key 15, the tripping parameter is adjusted in the selected LCD display 2 through 9a in such a manner that, each time key 15 is pressed, the adjustment value is increased in the predefined steps or even continuously. In this context, as ~~already explained~~ described above, the grading can be stepped coarsely or finely in the case of a bar display, as well as finely stepped to stepless in an alphanumeric display. When the highest value is reached, LCD display 2 through 9a returns to the lowest value the next time key 15 is actuated so as to increase again in response to further actuation.

Third key 16 for activating LCD displays 2 through 9a keys is pressed only if the switch is not connected to the electrical

network or switched off, i.e., if no voltage is applied to the auxiliary release. Then, in fact, an auxiliary supply is brought into circuit for the adjusting device. Otherwise, this device is always active. The auxiliary supply can be a battery or a capacitor which retains its charge for days if it is not brought onto load, and which is able to energize electronic loads having low current consumption of the order of microamperes for hours. It is also possible to use LCD elements which, irrespectively of whether alphanumeric or graphic displays are used, permanently present the information to be displayed without supply of energy, subsequent to feeding the information to the display. This makes it possible for the power demand to be further reduced since the control power which needs to be supplied during the adjustment of the auxiliary release in the zero-current state must be provided only for a short time. LCD elements of that kind are offered by the Kent company.

For the sake of completeness, it should also be mentioned that the combination of a rugged and insensitive key with an easily recognizable LCD element per se, as the root idea of the invention, does, of course, not enable the electronic tripping device itself to be adjusted. To this end, as schematically shown in Figure 4, a corresponding adjusting circuit 17 or the like is to be provided, which is controlled via keys 14 through 16, and to which, on one hand, LCD display 2 through 9a, which is visible to the user, is connected as output element, and from which, on the other hand, the internal signal for tripping device 18 is derived. For this purpose, a plurality of possibilities exist.

The advantages of the present invention are that rugged key switches are used in lieu of the usual miniaturized, delicate adjusting elements, and that an easily readable LCD display is provided in place of the small scales of the mentioned small adjusting elements, which are hard to recognize. LCD displays have by far the lowest current consumption and, consequently,

offer the possibility of making these adjustments even while the switches are switched off, using a simple auxiliary power source which can be made available in an inexpensive manner. Moreover, it is possible to use LCD elements which, irrespectively of whether alphanumeric or graphic displays are used, permanently present the information to be displayed without supply of energy, subsequent to feeding the information to the display. This makes it possible for the power demand to be further reduced since the control power which needs to be supplied during the adjustment of the auxiliary release in the zero-current state must be provided only for a short time.